PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : A01B 49/06

A1

(11) International Publication Number: WO 98/03053

(43) International Publication Date: 29 January 1998 (29.01.98)

(21) International Application Number: PCT/GB97/01554

(22) International Filing Date: 10 June 1997 (10.06.97)

(30) Priority Data:
9614991.9 17 July 1996 (17.07.96) GB

(71) Applicant *(for all designated States except US)*: KVERNELAND KLEPP A/S [NO/NO]; N-4344 Kvernaband (NO).

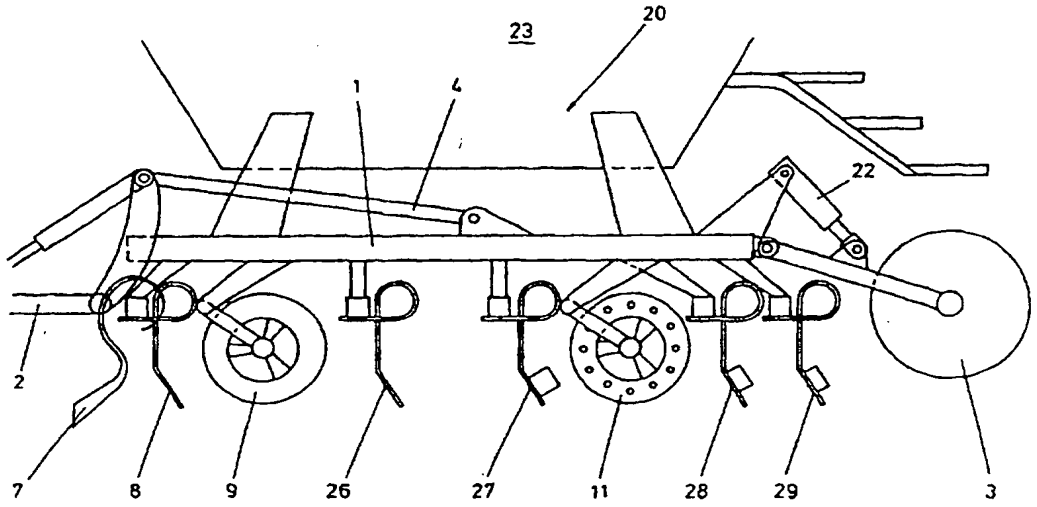
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: SKJEVELAND, Magne [NO/NO]; Theodor Dahls Vei 32, N-4062 Klepp Stasjon (NO).

(74) Agent: ORR, William, McLean; Urquhart-Dykes & Lord, Tower House, Merrion Way, Leeds LS2 8PA (GB).

(81) Designated States: AU, CZ, EE, PL, UA, US, European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: INTEGRATED SOIL CULTIVATING APPARATUS



(57) Abstract

An integrated soil cultivation apparatus (20) which is intended to be coupled to the rear of a propelling vehicle and to carry out a number of different soil-working operations during forward movement of the apparatus (20) by the vehicle, said apparatus (20) comprising: a frame (1); a coupling (2) arrangement at the forward end of the frame (1) to couple the apparatus (20) to the rear of the propelling vehicle; transversely extending rows of harrow tines (8, 26, 27, 28, 29) mounted on the frame (1); a roller-type of soil packer (9, 11) mounted on the frame (1) and extending generally parallel to the rows of harrow tines, said packer (9, 11) being adjustable relative to the frame (1) so that the engagement of the packer (9, 11) with the ground controls the working depth of the harrow tines; and, a first transversely extending row of seed coulters (28, 29) mounted on the frame and a second transversely extending row of fertiliser distributing coulters (27) also mounted on the frame, in which one of the rows of coulters is arranged forwardly of the packer (9, 11) and the other of the rows of coulters is arranged rearwardly of the packer (9, 11).

FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AL	Albania	**ES**	Spain	**LS**	Lesotho	**SI**	Slovenia
AM	Armenia	**FI**	Finland	**LT**	Lithuania	**SK**	Slovakia
AT	Austria	**FR**	France	**LU**	Luxembourg	**SN**	Senegal
AU	Australia	**GA**	Gabon	**LV**	Latvia	**SZ**	Swaziland
AZ	Azerbaijan	**GB**	United Kingdom	**MC**	Monaco	**TD**	Chad
BA	Bosnia and Herzegovina	**GE**	Georgia	**MD**	Republic of Moldova	**TG**	Togo
BB	Barbados	**GH**	Ghana	**MG**	Madagascar	**TJ**	Tajikistan
BE	Belgium	**GN**	Guinea	**MK**	The former Yugoslav Republic of Macedonia	**TM**	Turkmenistan
BF	Burkina Faso	**GR**	Greece			**TR**	Turkey
BG	Bulgaria	**HU**	Hungary	**ML**	Mali	**TT**	Trinidad and Tobago
BJ	Benin	**IE**	Ireland	**MN**	Mongolia	**UA**	Ukraine
BR	Brazil	**IL**	Israel	**MR**	Mauritania	**UG**	Uganda
BY	Belarus	**IS**	Iceland	**MW**	Malawi	**US**	United States of America
CA	Canada	**IT**	Italy	**MX**	Mexico	**UZ**	Uzbekistan
CF	Central African Republic	**JP**	Japan	**NE**	Niger	**VN**	Viet Nam
CG	Congo	**KE**	Kenya	**NL**	Netherlands	**YU**	Yugoslavia
CH	Switzerland	**KG**	Kyrgyzstan	**NO**	Norway	**ZW**	Zimbabwe
CI	Côte d'Ivoire	**KP**	Democratic People's Republic of Korea	**NZ**	New Zealand		
CM	Cameroon			**PL**	Poland		
CN	China	**KR**	Republic of Korea	**PT**	Portugal		
CU	Cuba	**KZ**	Kazakstan	**RO**	Romania		
CZ	Czech Republic	**LC**	Saint Lucia	**RU**	Russian Federation		
DE	Germany	**LI**	Liechtenstein	**SD**	Sudan		
DK	Denmark	**LK**	Sri Lanka	**SE**	Sweden		
EE	Estonia	**LR**	Liberia	**SG**	Singapore		

INTEGRATED SOIL CULTIVATING APPARATUS

This invention relates to an integrated soil cultivating apparatus which is intended to be coupled to the rear of an agricultural tractor or other propelling vehicle, and to carry out a number of different soil-working operations so as to carry out improved preparation of a seedbed and to introduce seed and fertiliser into the seedbed.

It is known to use harrows to break-down previously ploughed soil, and which have harrow tines mounted on them and which are pulled through the ploughed soil so as to exert a working operation on the soil. The working operation loosens the soil structure, and also tends to break-down soil clods or clumps into smaller fragments.

It is also known to use so-called "packers", which comprise sets of discs or rings which are freely rotatable about a generally horizontal axis, and which are trailed behind a tractor after a ploughing operation. The rings are set into rotation by engagement with the ground, and exert a powerful working operation on the ploughed soil to break it down and to form a seedbed. Packers can be trailed behind a tractor in a separate operation, after ploughing has been completed, or can be "integrated" with a plough so that a combined ploughing and soil-working operation is carried out.

Harrows may use different types of tine to engage and to work the ground, and including so-called S-tines, and finger tines, and the shape and arrangement of the tines can be selected according to requirements.

It is also known to provide a "combination" implement (soil cultivator) which includes tine features of a harrow, plus additional soil-working tools, such as levelling boards, crumbler rollers, and studded rollers. These types of soil-working tools are well known to those of ordinary skill in the art, and need not be described in more detail herein.

One example of a combination type of cultivator is the Kverneland Combinator II, which is mounted on the rear linkage of a tractor, and can have up to six successive soil-working zones, namely a soil levelling board in zone 1 which begins the seedbed forming process and levels the soil, zone 2 which

comprises two rows of strong S-shaped tines which loosen the soil to the desired depth, and the angle of which can be adjusted as required according to the nature of the soil; and zone 3 which comprises a heavy duty crumbler roller which crushes any clods left by the tines in zone 2. At the same time, the roller packs and levels the soil in preparation for the subsequent zones. Zone 4 comprises two further rows of S-shaped tines which carry out a final cultivating operation, to give a well prepared and level seedbed. Zone 5, and an optional zone 6, can comprise a combination of studded rollers and / or finger tine harrows which crush any remaining surface clods and lightly re-pack the soil.

Other examples of combination type cultivators include the Kverneland TTA trailed seedbed cultivator, and the Kverneland mounted TLA cultivator.

Combination type of soil cultivator implements operate generally satisfactorily, and the different types of soil-working tools which are provided, and their arrangement on the frame of the implement, will be selected to meet requirements, depending primarily upon the nature of the soil which is being worked.

However, although the combination type of soil cultivator works well in practice, there is an ever-present demand for still further improvements in seedbed preparation, and the present invention has been developed with a view to address this need.

Thus, in the preparation of a good seedbed i.e. one which allows uniform germination of seed, and healthy growth, the following objectives are highly desirable:

(a) a precise working depth of the soil-working tools to ensure correct planting depth, in that non-uniform planting of seed can result in variation in rate of germination, and in some cases failure of germination altogether;

(b) deposition or formation of coarser soil particles at the surface to give good oxygenation while protecting the soil against moisture loss and capping from rain damage;

(c) a layer of fine soil particles below the surface to

form the basis of the seedbed, and to provide a good contact between the soil and individual seeds; and,

(d) light compaction only of the seedbed to re-establish capillary action with the soil, enabling the seeds to absorb the necessary amount of water from the undisturbed soil below the seedbed in order to begin the germination process.

The invention seeks to provide improved preparation of the seedbed, by controlling the depth of penetration of soil-working tools into the ground, and to introduce seed and fertiliser into the seedbed as, or immediately after it is prepared.

The invention is defined in claim 1, and preferred aspects are defined in the subordinate claims.

Preferred embodiments of multi-tool type of soil cultivator according to the invention will now be described in detail, by way of example only, with reference to the accompanying drawings, in which:

Figure 1 is a schematic side view of a first embodiment of trailed seedbed cultivator according to the invention, having at least two different types of soil-working tool mounted thereon;

Figure 2 is a diagrammatic plan view of the apparatus shown in Figure 1;

Figure 3 is a diagrammatic rear view of part of the apparatus shown in Figures 1 and 2;

Figure 4 is a side view of a harrow-type tine integrated into a seed and / or fertiliser distributing coulter;

Figure 5 is an illustration of a seed growing upwardly through a seedbed created by the cultivator, and also having a root system growing downwardly through the soil;

Figure 6 is a diagrammatic plan view of a pattern of simultaneous distribution of fertiliser and seed into the seedbed, using the cultivator according to the invention;

Figure 7 is a diagrammatic illustration showing the growth of the seed and how it comes into subsequent contact via its root system with the fertiliser which is introduced to a lower depth in the seedbed; and,

Figure 8 is a schematic side view of a second embodiment of the invention which is capable of being fully mounted on the usual 3 link lifting mechanism of a tractor.

Referring now to Figures 1 to 3 of the drawings, there is shown, mainly by diagrammatic illustration, an embodiment of trailed integrated or combination type of soil cultivating apparatus according to the invention. The apparatus is designated generally by reference 20 and is intended to be coupled to the rear of a tractor or other propelling vehicle 21, and to carry out a number of different soil-working operations during forward movement of the apparatus 20 by the vehicle 21.

The apparatus 20 comprises a main frame 1, and which usually will have a length of about 3 meters, in order to mount the number of rows of soil-working tools which are required to be mounted on the frame 1, and spaced apart from each other along its length i.e. spaced apart from each other with respect to in the direction of forward travel of the apparatus. A coupling arrangement is provided at the forward end of the frame 1, to couple the apparatus to the rear of the vehicle 21, and in the illustrated arrangement is shown schematically by a drawbar 2.

The width of the apparatus 20, in its operative mode, will be selected according to the required area of ploughed ground which is required to be cultivated during each pass of the apparatus, and it might have a width (measured in the direction perpendicular to the direction of forward travel) in the range 3 meters up to 9 meters, and in a typical example a width of about 7 meters. However, since it will be quite impractical to transport an apparatus of width 7 meters (in its operative mode), at least one, and preferably a pair of foldable "wings" is pivotally connected to the sides of a central part of the frame, and which can pivot between a substantially horizontal and operative position, as shown in Figure 2, and an upwardly and slightly inwardly folded transport position of much reduced overall width, whereby the apparatus 20 can be towed through a gateway or other entrance

to a field, and along the public highway. However, a smaller version of the apparatus might have an operative width of about 3 meters, in which case folding to a transport position may not be necessary.

During transport of the apparatus 20, the forward end of the apparatus is supported by the drawbar 2 and its coupling to a rear hitch of the vehicle 21, whereas the rear part of the frame 1 is supported by a pair of vertically adjustable transport wheels 3. The wheels 3 can be vertically adjusted by hydraulic rams 22, or other power or manually operated adjustment devices. It should be understood that the wheels 3 are required only for the purposes of wheeled transport of the apparatus 20, and that the wheels will be raised completely out of contact with the ground during soil cultivating operations. The wheels 3 are therefore the only wheels used to support the apparatus, and then only during transport. There are no other wheels provided to support the apparatus, and it follows therefore that there are no wheels provided for depth control purposes during soil cultivating operation.

As will be described in more detail below, depth control during operation is controlled by one or more roller-type of packer, (comprising a set of packer discs or rings as well known to those of ordinary skill in the art).

The general frame 1 of the apparatus therefore can be raised, relative to the ground, when the ground wheels 3 are lowered into ground contact, whereas the frame 1 is lowered to a working position when the wheels 3 are raised out of contact with the ground. In order to maintain the attitude of the frame 1 generally parallel to the ground surface, during this upward and downward adjustment, an automatically operating adjustment mechanism 4 is provided. Mechanism 4 comprises pivoted linkages coupled with the frame 1 and operative to maintain a generally parallel attitude of the frame 1 during height adjustment. The mechanism 4 is only shown diagrammatically, but could be as shown in e.g. the adjusting mechanism disclosed in EPA 9410000.9.

The apparatus 20 is primarily a multi-tool soil

cultivation apparatus, but a particularly preferred additional feature applied to the apparatus is the provision of a seed distribution system, which is "integrated" with the apparatus, and which is capable of distributing seed at required planting depth in the seedbed formed by the apparatus. The seed distribution system is not shown in detail in the drawings, but will include a supply tank, an air driven distribution system which receives seed from the tank, and distributes it along distribution pipes to rear mounted "coulters" which introduce the seed at the required planting depth into the seedbed which has been formed by the preceding soil cultivation tools.

As indicated above, the seed distribution system is not shown in the drawings in detail, but there is schematic illustration of seed tank 23, which is mounted on a central part of the main frame 1, and which is long, but relatively narrow, so as to allow upward and inward folding of a pair of side frame wings 24 of the apparatus, which can fold upwardly about longitudinal side pivot axes 25 of the main central part of the frame 1, to take-up the transport position.

Returning now to description of the soil cultivating tools mounted on the frame of the apparatus, a number of separate rows of harrow tines are mounted on the frame, and comprise in particular a forward row of "levelling" tines 8 (which will be described in more detail below), front and rear sets of intermediate tines 26 and 27, and a rearward pair of rows of tines 28 and 29. The tines 28 and 29 are incorporated into coulters for the purposes of seed distribution at required planting depths, and the rear set of intermediate tines 27 are incorporated into fertiliser distributing coulters. Preferably, track looseners 7 are mounted in front of the tines of the foremost row 8, as shown schematically in Figures 1 and 2.

In addition to the rows of tines, the frame of the apparatus also has mounted thereon a packer 9 comprising a set of axially spaced packer discs or rings, mounted behind the foremost row of tines 8, and there is also a further packer 11, composed of sets of spaced packer discs, and which is arranged

between the rows 27 and 28.

Figure 2 is a diagrammatic plan view of the soil-working tools of the apparatus, and Figure 1 is a schematic side view. It can be seen in particular from the side view of Figure 1 that the tines in each of the rows 8, 26, 27 and 28 are of the same design, and are of circular cross-section, and similar to "finger tines" used on a harrow.

The foremost row 8 of tines comprise hydraulically adjustable "levelling tines", whose depth can be adjusted, and which are capable of carrying out a preliminary soil-working action, and which replaces the action normally provided by a known forwardly mounting "levelling board".

Turning now to the packers 9 and 11, it is believed to be unique to employ at least one packer as an integral component part of a harrow type of soil cultivator, and the forwardly mounted packer 9 has a dual function. It is manually depth adjustable, and incorporates spring-loaded packer rings, which are capable of crushing clods to break them down, and also of "packing" the soil. However, in addition to carrying out a "packing" function, the packer 9 also serves to provide for depth control of the forward part of the apparatus. The packer discs therefore perform the dual function of carrying out soil-working (packing), but also depth control, and this is an important aspect in the preparation of a seedbed, namely that the soil should be worked and cultivated, and crumbled down to the depth at which the seed is to be introduced. It is important, as far as possible, to keep the cultivation depth substantially constant, so that upon subsequent introduction of seed, this can be into substantially uniform seedbed conditions, and to substantially constant planting depth, so as to obtain as even germination as possible.

The discs or rings of the packer 9 can be of simple disc or ring form, as shown schematically in Figure 2, whereas the rearward packer 11 may comprise axially spaced discs provided with additional soil-working elements e.g. projecting knobs or projections, to assist in the crushing of any remaining clods formed during the soil-working operations of the preceding

soil-working tools.

The packer 11 is also manually adjustable as to its depth, for the purposes of providing depth control of the rear part of the apparatus. The rings of packer 11 also are spring-loaded, to assist the soil-working operation.

Finally, as mentioned above, the two rearmost rows 28 and 29 also comprise manually height adjustable tines, but incorporated into coulters for the purposes of introducing seed at required planting depth into the seedbed.

One preferred example of incorporation of a harrow-type tine into a seed and / or fertiliser distributing coulter is shown in Figure 4, to which reference will now be made. The coulter design of Figure 4 may be used to form fertilisers distributing coulters along intermediate row 27, and seed distributing coulters along rows 28 and 29. However, in the case of fertiliser distribution, it will be highly desirable for the depth of the introducer tip of the coulter to be located deeper than the introducer tips of the seed distributing coulters. Furthermore, desirably each fertiliser distributing coulter is arranged approximately mid-way between a trailing pair of seed distributing coulters.

The coulter shown in Figure 4 is designated generally by reference 40 and incorporates circular cross section harrow-type tine 10 supported at its upper end via a mounting platform 41, to which it is secured by nuts 42 and threads 43, and the downwardly projecting portion of the tine 10 is maintained in this upright position, but is capable of being deformed longitudinally i.e. in the direction of travel against resilient opposition provided by coils 44.

A rigid tube 45 distributes seed, (or fertiliser) 46 to a closed box 47 having a lower outlet 48. The box 47 is secured via its front face to a tine "point" 49, which is removably attached to the lower end of the tine 10 via fixing bolt 50. Flexible fingers 51 project downwardly and rearwardly from the platform 41, and serve to smooth down the surface of the seedbed (with seed introduced into it).

Figure 4 shows by reference 46 seed or solid fertiliser,

by way of example only. It should be understood that the distribution system can readily be modified to discharge doses of liquid fertiliser, if required. A flexible supply tube (not shown) is coupled to the upper end 52 of rigid tube 45, and leads to any suitable reservoir containing the seeds and fertiliser as appropriate.

The growth of the seed, after introduction of seed and fertiliser into the seedbed, will now be described with reference to Figures 5 to 7 of the drawings. Figure 5 shows a typical seedbed 60 which may be formed by the cultivator according to the invention, comprising a top layer of coarse particles 61, and a lower layer of fine particles 62, and seed 63 at its planting depth in the seedbed 60. Figure 5 shows the upwardly extending stalk 65, and a downwardly extending root system 66.

Referring now to Figure 6, this is a diagrammatic plant illustration of the pattern formed by the fertiliser and seed introduced into the seedbed by the cultivator. The fertiliser distributing coulters 27 are arranged one each between a respective pair of seed distributing coulters 28, 29, so as to form lines of fertiliser 67, and seed 68 as shown. In addition, the lower ends of the coulters 27 project more deeply into the ground than the coulters 28 and 29, so that the fertiliser is introduced into the ground at a lower depth than the seed.

Figure 7 shows how this has a favourable influence on the germination, and growing of each seed 63, in that the seed germinates, and then generates upward growth, and downward development of the root system, before coming into contact with the fertiliser (shown schematically by reference 69 in Figure 7) which is introduced at a greater depth into the soil by the cultivator.

This gives improved germination and growth of the seed, when compared with existing methods of introducing fertiliser and seed into a seedbed. Existing methods do not ensure that the fertiliser is introduced at a lower depth, but just generally introduces seed and fertiliser into the seedbed,

often in close proximity, and close contact between an ungerminated seed and fertiliser can in fact be positively harmful to the germination and growth of the seed. By contrast, by arranging the fertiliser 69 at a greater depth, this allows the seed to germinate, and carry out initial development of upward and downward growth (from its own resources), and only comes into contact with the fertiliser when the root system has been developed to an appreciable extent, and when it is then more receptive to, and in greater need of nutrients which it then derives from the fertiliser.

Desirably, a seed tank or reservoir is carried by the frame of the implement, whereas the fertiliser tank or reservoir preferably is carried at a suitable mounting point on the tractor.

During normal operation of the soil cultivation apparatus as described and illustrated herein, it will be possible to carry out both soil cultivation, seed drilling and fertilising at the same time. However, if any ground conditions should happen to be so hard and severe that it is unsuitable for seed drilling during the first pass, it is possible to shut-off the supply of seed and fertiliser to the coulters, and to carry out soil cultivation over any particular severe part of the field more than once, until the soil condition and the seedbed formation is satisfactory for drilling and fertilising. The feed of seed can then be renewed. However, evidently when the coulters are not supplied, the tines of the rows 27, 28 and 29 function solely as soil cultivation tools.

Returning now to the description of the first embodiment of Figures 1 to 3, in general terms, it will be apparent that this is a trailed machine, in the sense that its forward end is connected to a draw-bar, and in the transport mode the rear end of the apparatus is supported by the lowerable transport wheels 3. However, in the soil-cultivating mode, the transport wheels 3 are raised, and the forward packer 9 supports the forward end of the apparatus frame 1, and the rear packer 11 supports the rear end of the frame 1.

The forward and rearward packers 9 and 11 respectively

therefore perform dual functions, namely they extend full width across the frame of the machine i.e. perpendicular to the direction of travel, so as to carry out soil-working operations i.e. "packing" of the loosened soil, and in addition serve to control the working depth of the other soil working components (tines, coulters etc) of the apparatus.

However, the invention is not restricted to trailed machines, but includes the alternative of semi-mounted and fully-mounted machines.

An alternative embodiment is shown in Figure 8 of the drawings, and in which parts corresponding with those already described are given the same reference numerals, and will not be described in detail again. The main difference is that the forward packer 9 is omitted, and therefore it is necessary to provide alternative vertical support for the forward end of the apparatus frame 1 in the operative position. The forward end 53 of the frame 1 is therefore adapted so as to be capable of being "fully mounted" on the usual top link and two lower links of a rear-mounted tractor lift mechanism. A headstock 54 is therefore mounted rigidly at the forward end 53 of frame 1, and its upper pivot end 55 is connected to tractor top link 56, whereas the pair of laterally spaced lower pivots 57 are each joined to a respective one of the pair of lower links 58.

The entire apparatus therefore can be raised to a transport position, by operation of the lift mechanism, for transport purposes and general manoeuvring, but when soil working operations are required, the forward end 53 of the frame 1 is lowered to a required height above the ground, and inclination of the axis of the frame 1, so that the sole packer 11 in this embodiment serves to assist in determining the working depth of the apparatus (in conjunction with the front mounted support via the lift mechanism), as well as carrying out soil crumbling or "packing" operations.

Figure 8 embodiment of cultivator, seed and fertiliser distributor operates in generally similar manner to the first embodiment, except that it is a fully mounted machine and excludes the front packer 9. Both embodiments provide a

fertilising distributing coulter immediately in front of the packer 11 which supports the rear part of the frame, and seed distributing coulters rearwardly of the packer 11. By this close co-operation between the coulters and the packer, and reliance on the packer to control the working depth of the machine, careful control can be maintained over the depth of introduction of seed and fertiliser into the seedbed which is formed by the cultivator.

Further, with the distribution of the coulters such that the pattern of introduction shown in Figure 6 can be obtained, i.e. moving transversely over the machine, the arrangement of coulters is fertiliser coulter, two seeder coulters, one fertiliser coulter and so on.

In a typical example, the seed could be introduced into the seedbed at a depth of about 4cm, whereas the fertiliser can be introduced at a depth of about 7 to 8cm. The depth will vary for different kinds of seed, and typical range of depths for seed might be 1 to 8cm, and the most favourable depth for the fertiliser will be at a greater depth below the seed, sufficient to allow the root system to develop before coming into contact with the fertiliser.

It will always be the case that the fertiliser should be introduced at a greater depth into the seedbed than the seed, and most desirably the fertiliser distributing coulters will be in front of the packer, with the seed coulters rearwardly of the packer. However, for certain conditions, it is possible that it may be advantageous to reverse the positions of the seed and fertiliser distributing coulters.

The embodiment of Figure 8 is a "fully mounted" machine, as described above, and this will usually be a smaller machine, with lesser weight than a trailed machine, since the weight is reduced because of omission of the transport wheels, as well as the exclusion of the front packer. The machine therefore can be shorter and lighter in weight than the trailed machine.

Furthermore, with the fully mounted machine, whose weight will be borne by the tractor, it will be desirable for at least one of the tanks to be mounted on the tractor, and it has been

found advantageous to mount the fertiliser tank on the cultivator, and the seed tank at the front of the tractor.

CLAIMS

1. An integrated soil cultivation apparatus (20) which is intended to be coupled to the rear of a propelling vehicle (21) and to carry out a number of different soil-working operations during forward movement of the apparatus (20) by the vehicle (21), said apparatus comprising:

a frame (1);

a coupling arrangement (2) at the forward end of the frame (1) to couple the apparatus (20) to the rear of the propelling vehicle (21);

transversely extending rows of harrow tines (8, 26, 27, 28, 29) mounted on the frame (1);

a roller-type of soil packer (9, 11) mounted on the frame (1) and extending generally parallel to the rows of harrow tines, said packer being adjustable relative to the frame so that the engagement of the packer with the ground controls the working depth of the harrow tines; and,

a first transversely extending row of seed coulters (28, 29) mounted on the frame and a second transversely extending row of fertiliser distributing coulters (27) also mounted on the frame, in which one of the rows (27) of coulters is arranged forwardly of the packer (9, 11) and the other of the rows (28, 29) of coulters is arranged rearwardly of the packer.

2. Apparatus according to claim 1, in which the fertiliser distributing coulters (27) are arranged forwardly of the packer (11), and the seed distributing coulters (28, 29) are arranged rearwardly of the packer.

3. Apparatus according to claim 1 or 2, in which the fertiliser distributing coulters (27) project, in use, to a greater depth into the soil than the seed distributing coulters (28, 29).

4. Apparatus according to any one of claims 1 to 3, in which the fertiliser distributing coulters (27) and the seed distributing coulters (28, 29) are arranged so that, in use, each fertiliser distributing coulter (27) defines a line of distributed fertiliser (67) which is substantially mid-way

between a pair of parallel lines of distributed seed (68).

5. Apparatus according to any one of the preceding claims, in which each coulter (27, 28, 29) incorporates a spring tine (10) of circular cross section.

6. Apparatus according to any one of the preceding claims, including a forward roller-type of soil working device (9) mounted on a forward part of the frame (1), and operative to support the forward end of the frame, and a rear roller-type of soil working device (11) mounted on the frame and arranged to support the rear part of the frame.

7. Apparatus according to claim 6, including a set of lowerable transport wheels (3) mounted at the rear of the frame (1), said wheels being lowerable into contact with the ground so as to raise the frame (1) and thereby allow the frame to be transported, and said wheels being raised out of contact with the ground when soil working operations are required, so as to bring the forward and rear packers (9, 11) into contact with the ground.

8. Apparatus according to any one of claims 1 to 5, including a headstock (54) mounted at the forward end of the frame (1), and operative to couple the apparatus in a fully mounted manner to the rear of the propelling vehicle, and in which said roller type of soil packer (11) is arranged to support the rear part of the frame (1) when the apparatus is lowered into contact with the ground.

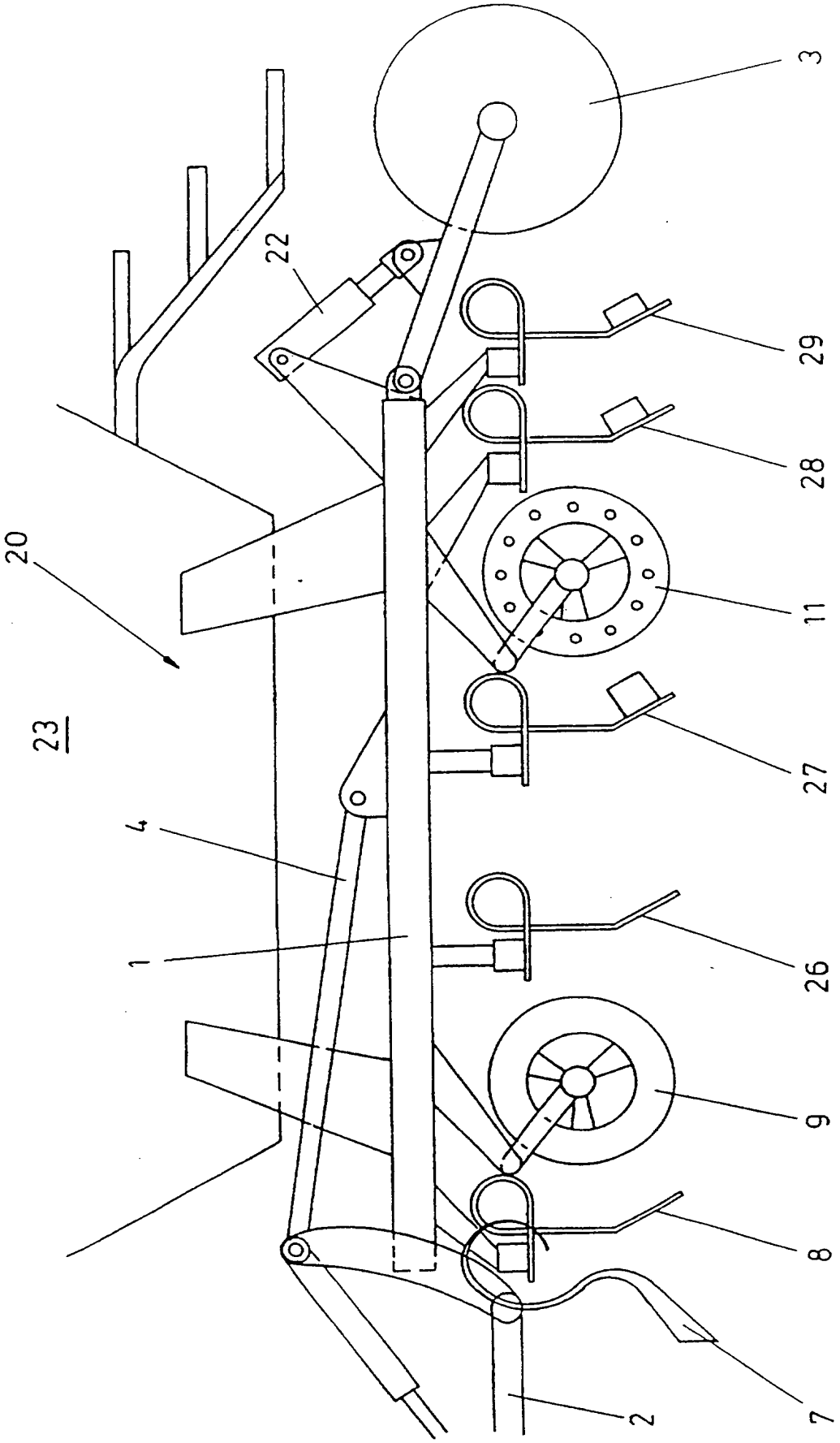


FIG. 1

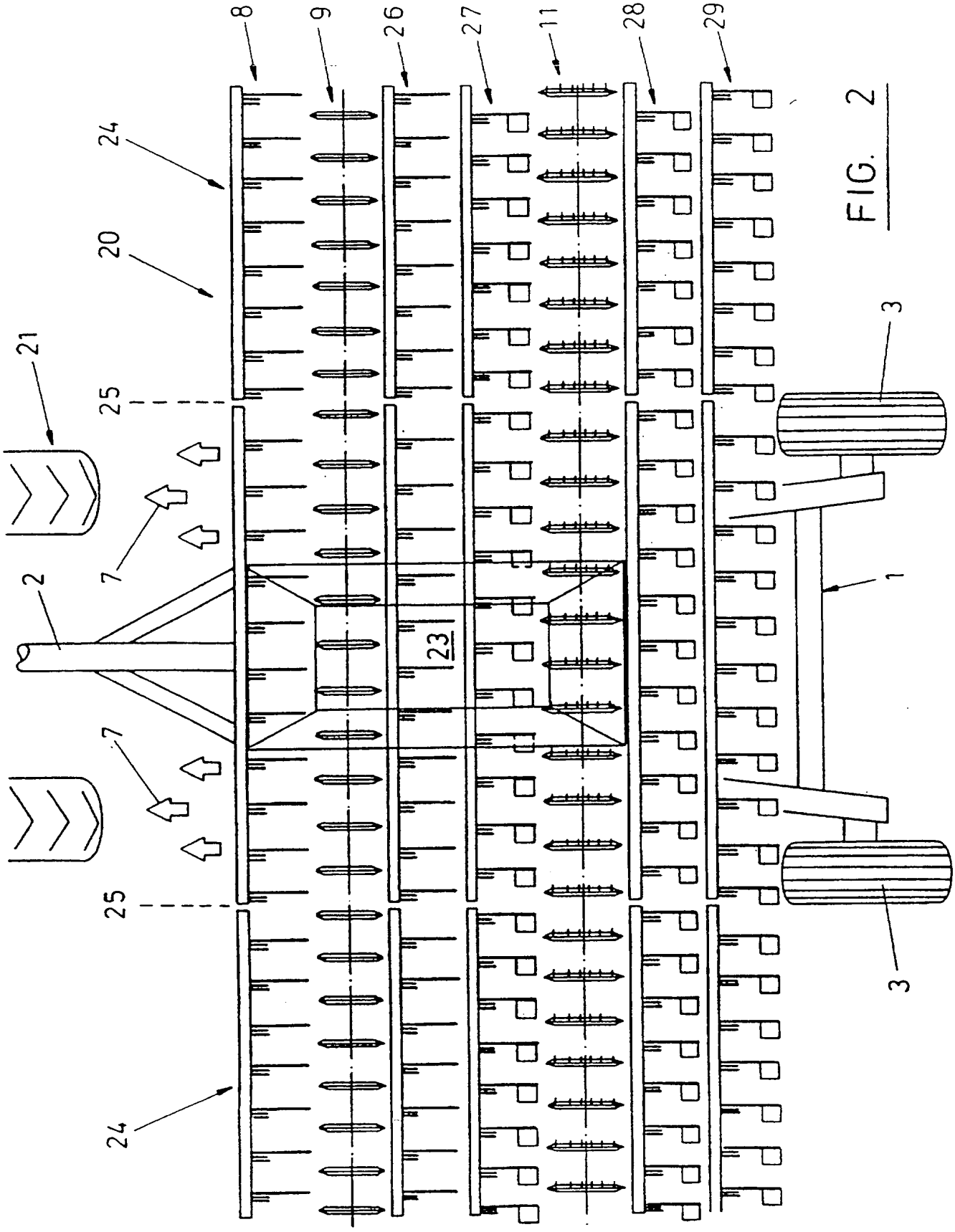


FIG. 2

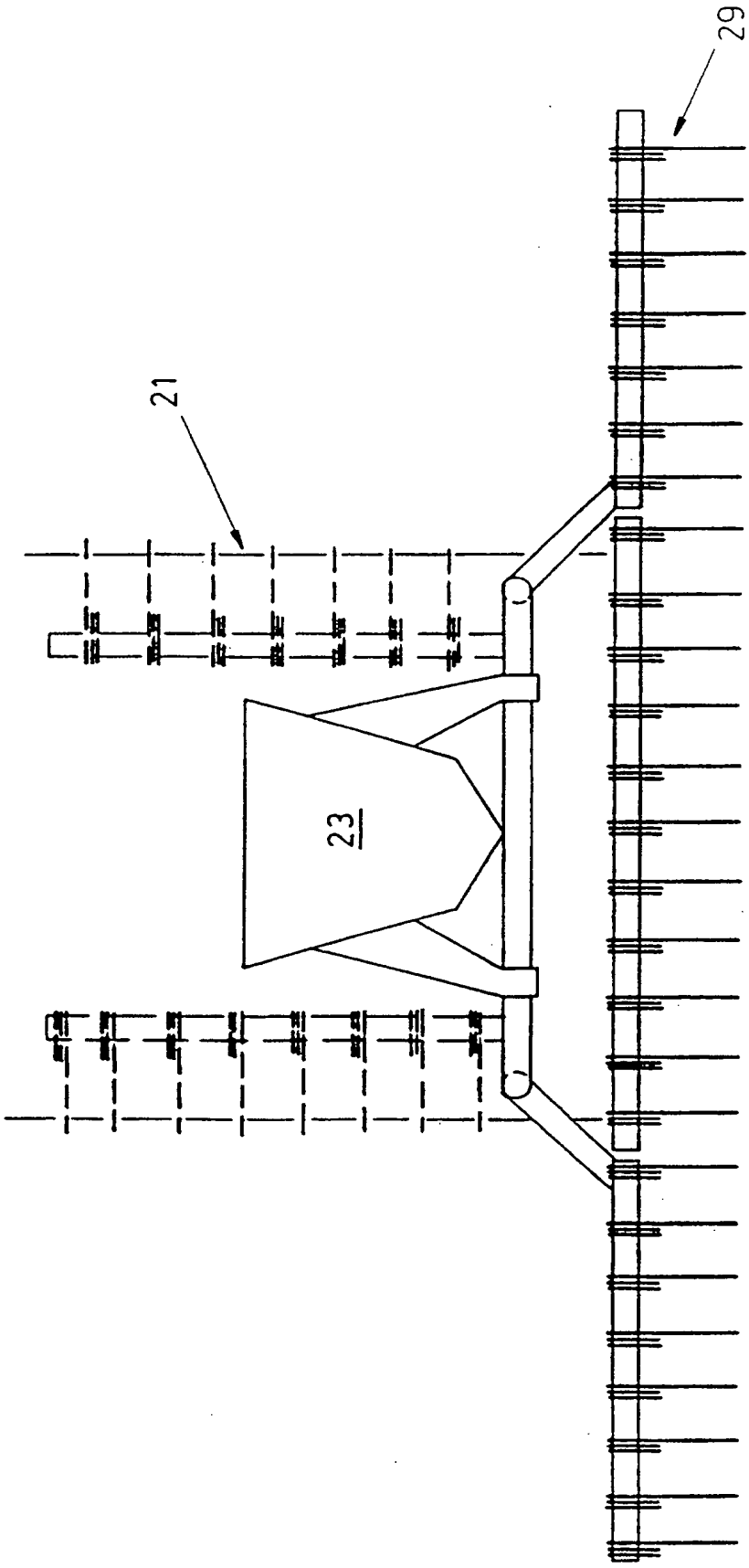


FIG. 3

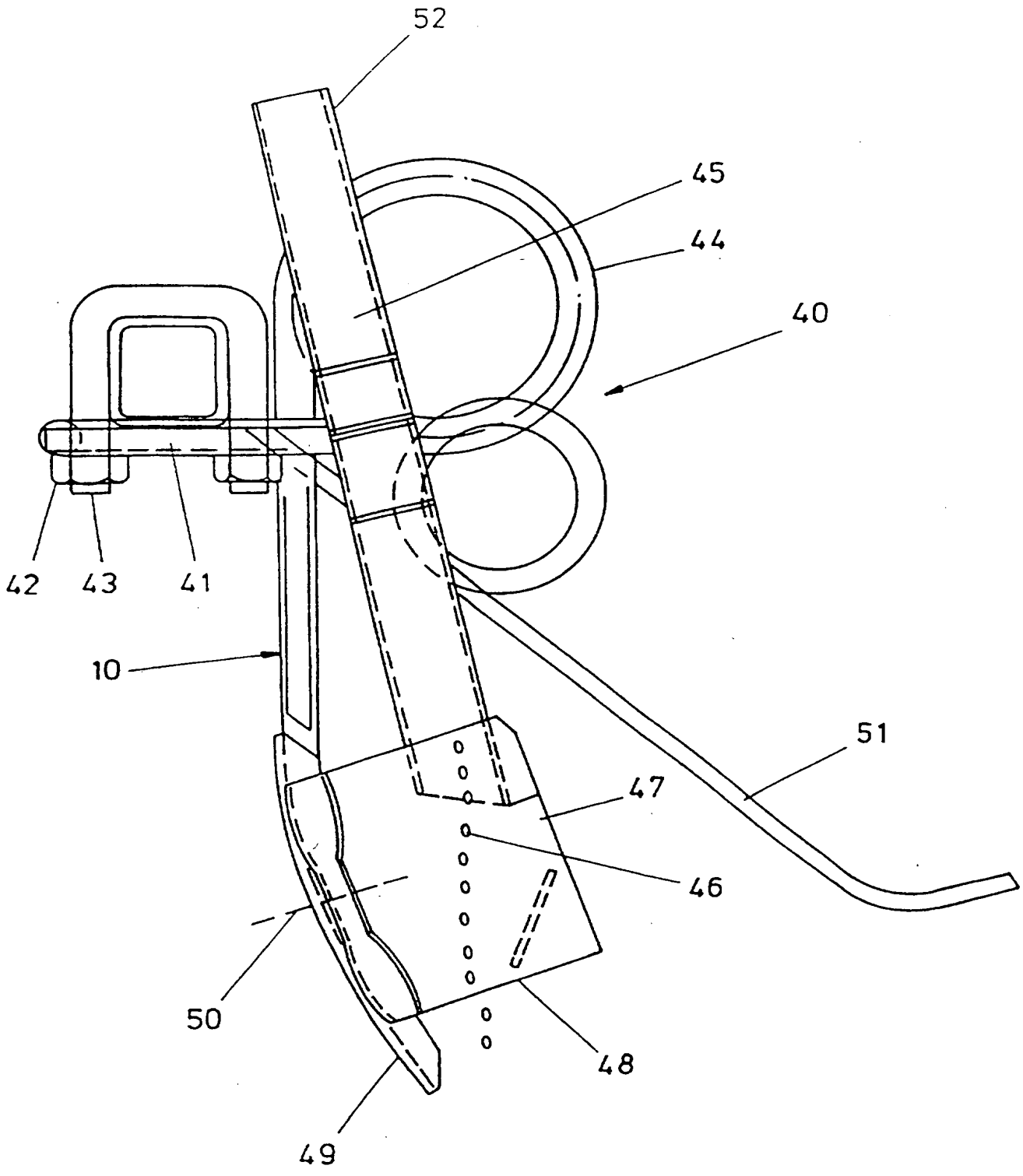


FIG. 4

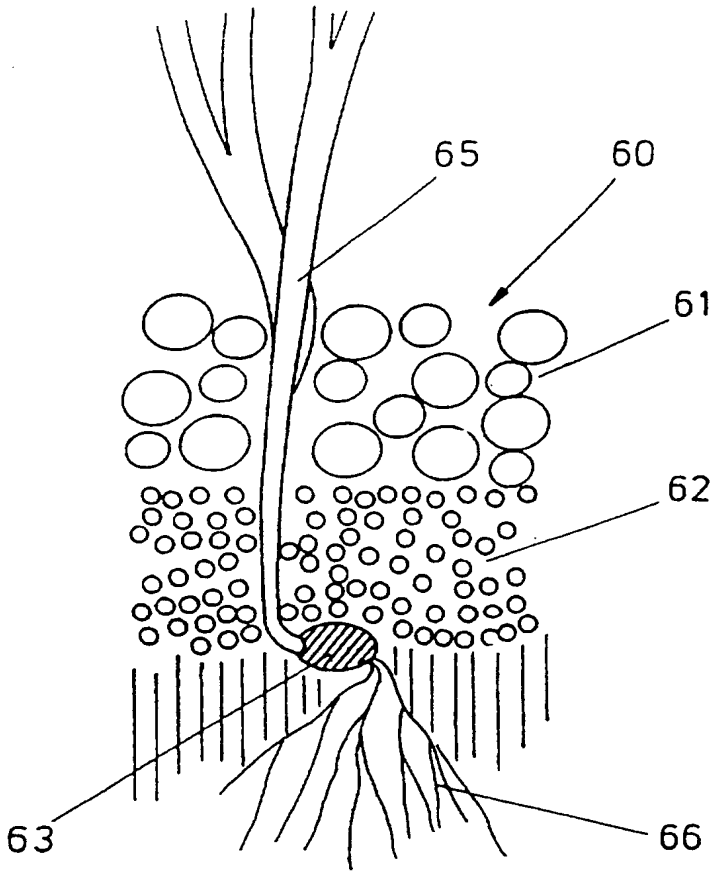


FIG. 5

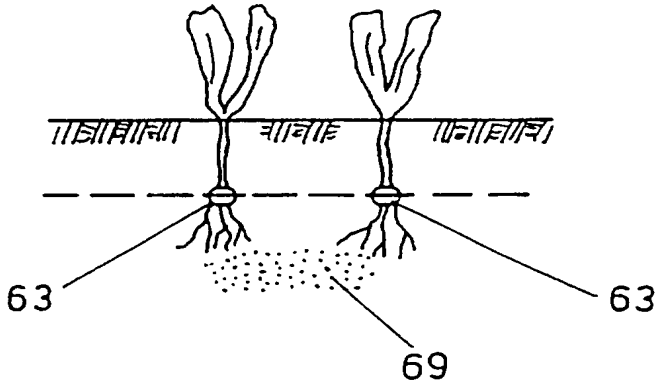


FIG. 7

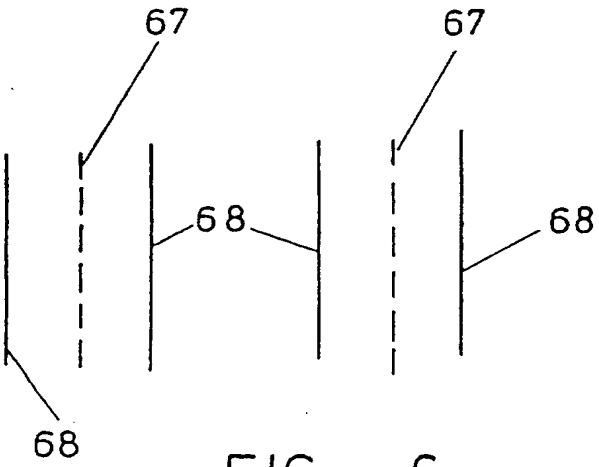


FIG. 6

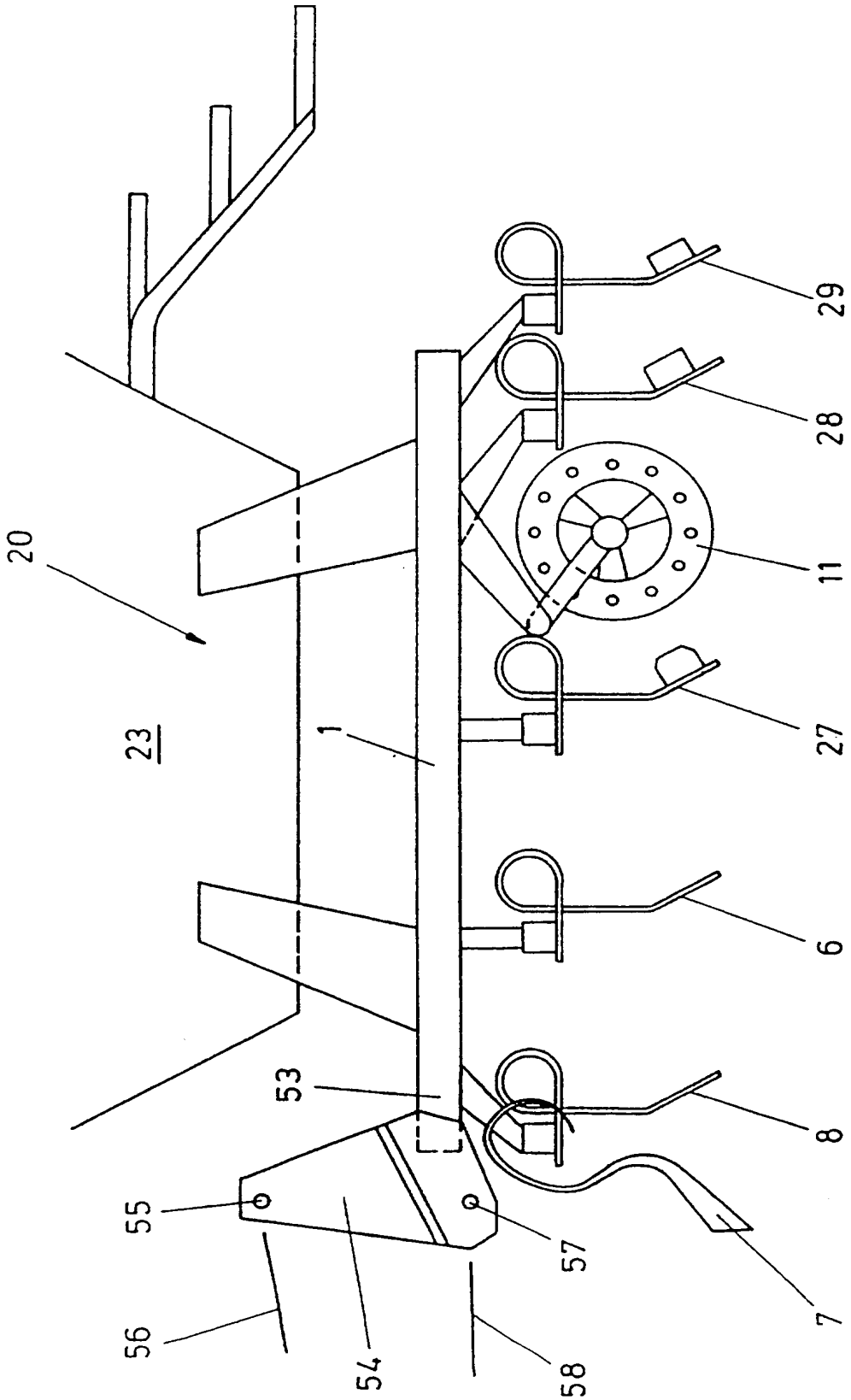


FIG. 8

INTERNATIONAL SEARCH REPORT

Interna ‹ Application No
PCT/GB 97/01554

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A01B49/06

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A01B A01C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 201 785 A (RAU) 20 November 1986 see abstract; figures see page 4, line 30 - line 32	1,5,7,8
Y	see page 20, line 26 - line 38	2-4,6

Y	GB 1 187 179 A (JUNNILA) 8 April 1970 see page 1, line 12 - page 2, line 15	2-4

Y	FR 2 624 686 A (CHAMPEL) 23 June 1989 see abstract; figures	6

A	EP 0 459 175 A (AMAZONEN-WERKE) 4 December 1991 see abstract; figures see column 2, line 49 - column 3, line 45	1

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 October 1997	27. 10. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Walvoort, B

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Interna l Application No
PCT/GB 97/01554

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 726 303 A (DEGELMANN) 23 February 1988 see abstract; figures	1,6-8
A	US 4 048 929 A (ZUMBAHLEN) 20 September 1977 see abstract; figures	1,7,8
A	DE 91 14 455 U (RAU) 18 March 1993 see figures	1,6
A	EP 0 358 947 A (GÜTTLER) 21 March 1990 see abstract; figures	1
A	FR 2 623 361 A (TAI) 26 May 1989 see abstract; figures	1
X,P	EP 0 770 319 A (KVERNELAND) 2 May 1997 see abstract; figures & WO 97 15179 A (KVERNELAND)	1-8

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Intern. al Application No
PCT/GB 97/01554

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 201785 A	20-11-86	DE 8532161 U	23-01-86
		CS 8603157 A	13-12-89
		DE 8529225 U	04-09-86
GB 1187179 A	08-04-70	BE 720832 A	17-02-69
		DE 1782477 A	26-08-71
		FR 1595598 A	15-06-70
		NL 6814010 A,B	22-04-69
FR 2624686 A	23-06-89	NONE	
EP 459175 A	04-12-91	DE 4015736 A	21-11-91
		CS 9101370 A	15-01-92
US 4726303 A	23-02-88	CA 1251997 A	04-04-89
		AU 5181086 A	04-06-87
US 4048929 A	20-09-77	US 4180005 A	25-12-79
DE 9114455 U	18-03-93	NONE	
EP 358947 A	21-03-90	DE 3827770 A	22-02-90
		DE 58906092 D	09-12-93
FR 2623361 A	26-05-89	NONE	
EP 770319 A	02-05-97	AU 6561296 A	01-05-97
		WO 9715179 A	01-05-97